GIS Outreach and Training Approaches for Decision-Makers and Educators to Ensure Data to Action in Local Watersheds.

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Biographical Sketch of the Authors

Jeffrey Schloss is a Water Resources Specialist for UNH Cooperative Extension assisting communities, lake / watershed associations, educators and agency staff on pollution prevention, and in the evaluation, inventory and stewardship of surface and groundwater resources. He is also a research scientist in the UNH Center for Freshwater Biology and currently involved in projects investigating GIS use for nutrient loading models, applications of remote sensing for water quality, determinants and indicators of productivity, long-term water quality trend analysis and the occurrence of cyanobacteria toxins. He also coordinates a statewide volunteer monitoring program. Nancy Lambert is a Natural Resources Specialist for UNH Cooperative Extension who works with communities, educators and students offering training and outreach in spatial technologies (GIS, GPS and remote sensing). She is the creator and the primary instructor for the Community Mapping course and also works in the development of short courses in GIS basics and advanced GIS application trainings. Fay Rubin is the coordinator of New Hampshire GRANIT (Geographically References Analysis and Information Transfer), the statewide GIS data repository. She works in the development, management, distribution and quality assurance of the majority of the GIS data available for the state. The authors have collaborated on various efforts to support spatial technology training, developing GIS data applications, and providing GIS outreach support to local decision makers and their communities, agency staff and educators.

Abstract

Two approaches using Geographical Information System (GIS) technology instruction for watershed resources training and outreach have proven successful in getting a wide range of environmental data into the local decision-making processes in coastal and inland communities throughout New Hampshire. Our first foray was an intensive two-week summer course called *Community Mapping*, initiated five years ago, and offered through the University of New Hampshire Environmental Education Institute by Cooperative Extension. It provides communities with the information and skills necessary to better manage and protect natural resources through the use of GIS technology. The target audience is community leaders and officials who are linked with middle school and high school educators from their respective towns. The intent of the targeting is that a partnership between decision-maker and educator will be formed to better develop the capacity for GIS-supported natural resources stewardship in their town. The second approach used was a year and a half biweekly (later changed to a year long weekly) training course targeted to coastal watershed decision-makers supported through a partnership with the NOAA Cooperative Institute for Coastal and Estuarine Environmental technology (CICEET) called *GIS for Coastal Community Decision-makers.* Both courses emphasize the need to create and use watershed and community natural resources inventories to make informed decisions concerning planning, management and conservation. State agencies and NGOs actively participate in the training. This allows them to make sure the trainees are up to date on their respective community assistance programs, their GIS data support and the specific limitation of the available data. Challenges, successes, surprises and the unique evaluation system designed to gauge program impacts are discussed.

Introduction

Increasing developmental pressures continue to threaten the water quality of our lakes, ponds, and estuarine systems throughout the country. In New Hampshire, for instance, increasing developmental pressures are converting the landscape from a rural, and predominantly forested landscape to a more urban setting characterized by an increase in paved surfaces, well manicured lawns (that usually include heavy applications of pesticides and fertilizers), and a loss of streamside (riparian) vegetation. Such landscape alterations, from forested to urban setting, often coincide with increasing water quality impairment. In addition, the last remaining open spaces, which include active and former agricultural lands, are also being lost at a rapid pace. In most of northern New England, the protection and stewardship of a town's resources fall under the local, often volunteer, decision maker. During the planning process, municipalities often fail to recognize the many natural resources that are at risk, and their benefits (i.e. wetlands, riparian buffers, large contiguous plots of land),and that, if properly managed and protected, can minimize some of the deleterious impacts of development within the watershed and help maintain the integrity of our surface and ground waters.

The advent of Geographic Information Systems (GIS) has brought a new and potentially powerful inventory, analysis and educational tool to watershed investigators and decision makers. Although GIS natural resource applications are often developed and explored on a statewide and regional scale there has been less effort to transfer and utilize the technology at the local level. In an attempt to address these complex issues, various method manuals have been developed to assist local officials and interested citizens in finding or assembling the information necessary for informed planning and decision-making. These valuable manuals include considerations for determining regulatory and voluntary buffers around water resources (Chase et al 1995), as well as a handbooks on community natural resource inventories (Auger and McIntyre, 1992; updated with expanded GIS discussion in Stone 2001). This latter work offers suggestions and provides examples of a resource inventory process that is based within the political boundaries of the community. This resource inventory process has also been adapted to demonstrate this approach in the context of a watershed based GIS assessment and analysis (Schloss and Ruben, 1992, Schloss 2002).

An intensive two-week summer course called *Community Mapping* was initiated five years ago by Cooperative Extension, and offered through the University of New Hampshire Environmental Education Institute. It provides communities with the information and skills necessary to better manage and protect natural resources through the use of GIS technology. The target audience is community leaders and officials and the middle school and/or high school educators from their respective towns. The hope is that a partnership between decision-maker and educator will be formed to better develop the capacity for GIS-supported natural resources stewardship in their town. Educators feel that involving their students in "real world" problem solving is a great way to maintain student interest while developing an important skill sets. Local decision makers are the ones who have the knowledge of the pertinent local issues but often do not have the time nor staff to undertake the GIS based projects that could allow them to deal with these issues with the proper knowledge base. Thus, the partnerships developed through this training had a synergistic impact benefiting both parties.

The second approach used was a year and a half biweekly training course targeted to coastal watershed decision-makers and supported through a partnership with the NOAA Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). UNH Cooperative Extension specialists and UNH faculty and cooperators refined the original *Community Mapping* course materials and developed an ArcView © GIS training using NH GRANIT data manual, a watershed natural resources reference guide, a workshop series, and training exercises aimed at educating local decision-makers (Town Planners, Conservation Commissioners, Selectmen, Planning and Zoning Board Members). The major emphasis of this *GIS for Coastal Community Decision-Makers* training was using GIS technology to enhance decision making and planning in coastal communities, both as an analytical tool (in performing a critical lands analysis) and as an inventory tool (in creating community natural resource inventories). Two separate training cycles (one targeted

to only the costal towns with shore lands and the other also opened to the other coastal watershed towns) consisting of a series of 14 training sessions each has been successfully delivered. The second series was modified to occur in a single year due to a late start due to a delayed funding cycle which necessitated changing the course to a weekly schedule. Surprisingly, this scheduling resulted in a better overall attendance and also maintained the training momentum better that the previous training that had a summer break to accommodate the bi-weekly schedule.

While the original intent of the trainings was to target specific local decision-makers, we have wound up training a wide range of individuals including:

- Planning Board Members
- Tax Assessors
- Town Engineers
- Town Planners
- Town GIS Technicians
- Master Planners
- Conservation Commissioners
- Building Inspector / Code Enforcement Officers
- Agency Personnel
- Formal and Informal Educators (K-12, Faculty, Nature Center Staff)
- Graduate Students
- Volunteer Monitors in our Great Bay Coast Watch and Lakes Lay Monitoring Program

The key to the training approach for both *GIS for Community Decision-Makers* and *Community Mapping* is that it does not just teach the mechanics of Geographic Information Systems (GIS), but it's instruction and training exercises are in the context of the locally available data for undertaking a community natural resources inventory and critical lands analysis. Key topics of the natural resources side of the training are:

- Resource Inventory Components and Approaches
- Developing a Resources Protection Plan
- Soil Properties, Characteristics, Importance and Development Implications
- Watersheds, Water Quality & Non-point Source Pollution
- Wetlands, and their Function
- Groundwater and Wellhead Protection Strategies
- Wildlife Habitat
- Buffers for Wildlife and Water Resources Protection
- Critical Lands Analysis
- Voluntary and Regulatory Land Protection Strategies

Participants also gain knowledge in desktop Geographical Information System (GIS) software. The major topics of instruction include:

- Navigating the Software
- Downloading and Importing Data Layers
- Merging Attribute Data
- Data Queries/Selecting by Location
- Geoprocessing (Merging, Buffering, Dissolve, Intersect, Union, Clip)
- Creating New Data
- On Screen Digitizing
- Global Positioning Systems Data Acquisition and Transfer to GIS

- Designing, Creating, and Producing Maps

Participants are given a collection of GIS data specific to their town, which they then use in "hands-on" exercises that follow each daily lecture. By completing these exercises, and undertaking a project selected by the participant, the result is a good start at the compilation of a GIS-based community natural resources inventory and in the creation and manipulation of a critical lands analysis approach.

Participants also become aware of the many sources and availability of the GIS data, the limitations of the GIS data, and how to interpret the GIS products that they and others produce. In addition, they learn about, and often have the chance to interact with, the many cooperators who produce and manage the GIS data, and/or can help support the towns and municipalities who are using GIS data. Using many of these service provider resources as guest lecturers during the course facilitates these interactions. Cooperators in this effort have included:

- Cooperative Extension Forestry, Wildlife, Water Resources Specialists/Educators
- Natural Resources Conservation Service Engineers/Scientists
- NH Natural Heritage Inventory Staff
- State / Regional Planning Agency Staff
- NH Fish and Game Educators
- NH Dept. of Environmental Services Personnel
- GRANIT (NH GIS Data Depository) Data Manager
- Environmental Consultants

The results have been quite remarkable for such a relatively basic and short duration of trainings; Through skills learned in *Community Mapping* teachers from several high schools have incorporated a GIS component into their curriculum. GIS has been used by one of our teachers to entice at-risk students to stay in school. One of these students has gone on to enroll in a GIS program at a technical college. Students have assisted their towns with resource inventory maps and in developing trails on town lands. One trainee who works at NH Fish and Game has developed GIS curriculum that will be used by teachers that will be participating in a statewide stream and river watershed education program. Teachers continually update us on the implementation of GIS by their students and the community services they are providing.

As a result of the *GIS for Coastal Decision-Makers* trainings participants have acknowledged that they are better able to communicate with GIS professionals and cooperators. Most of these are comfortable and knowledgeable about asking other cooperators and providers for the appropriate data and GIS products, and many are able to support some of their own, and town, GIS needs as well. Local towns are using GIS in their planning process, including using the natural resources inventory to formulate or update their Master Plans. Local towns are also using the GIS maps that participants produced for town board, committee, and public sessions. The course has also provided a venue for networking between town educators and decision-makers, which has lead to the formation of watershed partnerships, greenway alliances, and other inter-town collaborations.

Evaluation

Even before this request (we were UNH Cooperative Extension educators after all) evaluation efforts constituted a significant component of the participants' activities in our initial training program. Originally, several instruments were developed and implemented, including a full program pre-evaluation to establish each participant's degree of familiarity with the subjects prrsented, and session-specific evaluations addressing content and delivery of the individual training modules (lectures by guest speakers and related GIS exercises). For *Community Mapping* the course end project was also useful for evaluation of training success. Additionally, for *GIS for Coastal Community Decision-makers* a year-end open discussion in each of the two

years provided important feedback on the training program. These evaluations had already assisted in our future project planning efforts and to improve existing course materials over time.

However, it was clear that a more formal evaluation of the program was needed to improve our ability to measure program impacts. One of the perceived weaknesses of the current evaluation approach was that it failed to provide us with a sense of how well we shepherded the participants and their communities along given the level of content or technical expertise that they started with. For example, consider that we had one participant who already had a basic knowledge of GIS and who came from a community already using GIS at some level who by the end of the training or soon after was able to get the Natural Resources Inventory incorporated in the town Master Plan. We also had a participant with no previous GIS knowledge, no existing GIS capacity in their town who was able to get GIS information on natural resources used at local decision-making meetings. How do we rate our success for each of these? Which had the greater impacts?

Given these information needs and with assistance from a professional evaluation consultant, we developed an improved method of evaluation. As part of this evaluation, we identified a series of important themes or threads that served as the basis of the training program (see Appendix I attached below). The learning threads used were GIS Knowledge, ArcView © Skills, and Community Natural Resource Knowledge. For each thread, we identified a continuum of skills and learning that participants could achieve. The learning/skills in the continuum can be categorized (in order of advancing difficulty) as follows:

- *Orientation*- a very basic understanding of what it is, why it is important, what is involved.
- *Preparation*- can tackle the basic "start-up" requirements to begin using the tool or skill.
- *Mechanical use*- can be lead through the use of the tool or skill.
- *Routine use*- able to use the skill or tool with confidence and explain concepts to others.
- *Refinement*- able to expand use of tool or skill to other situations or use/create new data.
- *Integration*- high degree of understanding/deployment/coordination; can transfer/teach tool skill

The use of this continuum approach allows for a more rigorous evaluation of our GIS outreach/training program impacts. It enables us to better document at what point in the continuum each participant started (pre-training level) and the extent to which they advanced along the continuum (post-training level and future use). Now we have a very structured way to document our training impacts

The consultant also worked with us to develop additional materials that allowed us to capture the information needed to conduct the continuum evaluation as well as data on impacts. Additional materials developed included an observer survey form that was used by a subset of our advisory committee when they observed our classes in progress. Discussion questions for our final "in-class" evaluation discussion session, a "take-home" post course evaluation, and a post-course interview conducted one on one and in person were also developed and implemented. The results of all of these evaluations have been compiled and a re-design of some of our original instruments (pre-course evaluation, individual lesson evaluations) has been completed to better collect data for this type of analysis approach.

Lessons Learned

When we first started training sessions in GIS applications we really had no idea if it was going to be able to build community decision-making capacity and get the natural resources data available used widely. We have been pleasantly surprised that even the most technology challenged trainee has reported impacts and has helped implement the data use in his/her community. What we thought would be a longer turnaround time for some significant impacts to be seen (year or years) has proven to be shorter than expected (months). In their own way the different approaches used in terms of training structure allows us to get participation from the diverse audience we wanted to target. Educators seem to be able to (and also prefer) work more intensively for a short summer training while volunteer or paid decision-makers mostly favored the more spread out approach.. The keys to success seemed to be: 1) Training the technology in the context of how the current data

are available, 2) Providing that data for use by participants in their exercises, 3) Providing detailed supporting materials to cover both the mechanics of how to use the technology and along with orientation to the concepts involved, 4) Utilizing the individuals/agencies responsible for providing the data in the training and covering the proper use of the data, 5) Working each exercise out by using a common data set then having students do it again with their specific data, 6) Offering many examples of how to use the data, 7) Developing an impact and evaluation system that can gauge success given the varied starting levels of participants and also feedback into improving the training methods.

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Appendix I. Evaluation Continuum Criteria

Level 0: Nonuse

I **Orientation**	**II** **Preparation**	**IIIA** **Mechanical**	**IIIB**	**IVA** **Routine**	**IVB**	**V** **Refinement**	**VI** **Integration**
Thread 1: ArcView Skills							
Knows what GIS and Arcview are	Able to load ArcView	Able to complete exercises (follow directions)	Able to complete homework	Able to apply data to their town	Able to apply different data to same problem	Able to create own/ new data	Able to acquire new data and apply to new problem
Knows some capabilities or uses of Arcview	Has access, to software, hardware, data	Able to use Arcview software	Able to create a map		Able to acquire new data from a variety of sources inc web	Able to take methods and apply to a different problem	Able to identify new capabilities
	Can use Windows (95/98) operating system	Able to communicate what Arcview is to others	Able to assist others to understand benefits/ limitations of Arcview	Able to communicate usefulness of ArcView to community given the data available	Able to identify & communicate data needs to a professional	Knows true (specific) data needs	Able to teach/assist others to use GIS/ArcView
Thread 2: GIS Knowledge							
Knows what GIS is Knows some capabilities of GIS	Basic familiarity with maps	Able to communicate what GIS is Benefits/ Limitations of GIS	Able to assist others to understand benefits/ limitations of GIS	Able to communicate appropriate use(s) of GIS for their community	Able to assist others in evaluating the use of GIS	Able to use GIS in decision-making	Able to assist and advise decision makers
Knows distinction between GIS map & data	Knows what GRANIT is & other GIS data sources	Knows enough to ask questions to get the info they need & where to go for answers	Able to evaluate appropriate uses for GIS in their comm. Able to display data on a map	Able to communicate with GIS Professionals	Knows what data should be on the map	Able to interpret maps	Able to teach others to interpret GIS data/maps

Level 0: Nonuse

I Orientation	II Preparation	IIIA Mechanical	IIIB	IVA Routine	IVB	V Refinement	VI Integration
Thread 3: Natural Resources Knowledge							
Knows What Natural Resources (NR) Are	Able to ID and Locate Important NR	Able to ID objectives for NR Inventory and needed inventories	Conducts basic Inventory identified by objectives inc. base maps	Conducts focused studies & compiles analysis & report	Develops NRP/S	Refines NRP/S	Implementation of the NR Protection Plan/ Strategy. It is used as a resource for town board decision making
Knows Importance of NR, NR Inventory, and NRP/S*	Able to ID and under-stands the risks to res.	Able to identify protection strategies	Able to ID stakeholders	Informs stakeholders throughout the NR P/S process	Able to make a presentation of/about the data	Facilitates use of P/S in decision making	Improved Water Quality, Reduction of Pollution, Protected Habitats and Open Spaces
Knows what a NR Inventory is	Able to ID available tools and resources for doing inventory	Able to access available tools and resources	Able to utilize approp. tools and resources in basic inventory	Able to use tools & resources in focused studies & analysis, compilation & development of report		Reviews/updates/ strengthens current natural resources related ordinances	ID future revisions/ updates necessary for NRP/S & Master Plan
Knows What a NR Plan/ Strategy (NRP/S) is	Understands the need for NRP/S	Informs towns people of importance of natural res. & NRP/S	Able to promote the need for NRP/S objectives	Able to ask questions & communicate with Regional Pl. & GIS professionals	'Sells" the NRP/S		Integration of NRP with other plans

*NRP/S = natural resources plan and/or strategy